insuring re-observation of these objects was by the determination, not of their absolute, but only of their relative, positions, through the agency of the larger "finder" of the great telescope. This has an aperture of five inches, a power of thirty diameters, and a field of view of seventy-eight minutes of arc. Two diagrams were usually drawn in the book for each of these objects,—the one showing the relation of adjacent objects in the great telescope, and the other the configuration of the more conspicuous objects in the field of view of the finder. Adjacent to these "finder" diagrams are the settings,—to the nearest minute of arc in declination, and of time in right ascension,—as read from the large finding-circles, divided in black and white. The field of view of the finder is crossed by two pairs of hair-lines, making a square of about twelve minutes on a side by their intersection at the centre. The diagrams in all cases represent the objects as seen with an inverting eye-piece. As the adjustment of the finder was occasionally verified, as well as the readings of the large circles, there should be no trouble in identifying any of these objects, notwithstanding the fact that no estimates of absolute magnitude were recorded. The relative magnitudes, while intended to be only approximate, are still shown with sufficient accuracy for the purpose of the research, and the diagrams are, in general, faithful tracings from the original memoranda.

[Mr. Todd transcribes the observing-book entire.].

PRIME MERIDIAN TIME[1]

On the first day of the month, the President of the United States, in his message at the opening of Congress, referred to the International Meridian Conference lately convened in Washington, in the following words:—"The Conference concluded its labours on November 1, having with substantial unanimity agreed upon the meridian of Greenwich as the starting point whence longitude is to be computed through 180° eastward and westward, and upon the adoption for all purposes for which it may be found convenient of a Universal Day, which shall begin at midnight on the initial meredian, and whose hours shall be counted from zero up to twenty-four."

The Canadian Institute is peculiarly interested in this announcement. No society, literary or scientific, has taken a more important part in the initiation of the movement to reform our Time-system, of which the success is, to some extent, indicated in the President's words. It therefore appears to me fit and proper that I should recall to your attention the various steps which from time to time have been taken, so that we may possess a record of the events which have led to the now almost general recognition of the necessity for a new notation.

Six years ago on several occasions the meetings of the Institute were engaged in discussing the subject of Time-reckoning and the selection of a Prime Meridian common to all nations. Papers were read and arguments were advanced, with the view of showing the necessity of establishing a cosmopolitan or universal time, by which the events of history might be more accurately recorded, and which would respond to the more precise demands of science, and generally satisfy the requirements of modern civilisation. The *Proceedings* of the Institute for January and February, 1879, give at considerable length the views submitted and the suggestions offered to meet the new conditions of life. While on the one hand it was argued that the introduction of a comprehensive scheme by which time could be universally reckoned was highly desirable, it was equally maintained that the determination of a common Prime Meridian for the world was the key to its success, and that the establishment of such a meridian, as a zero, recognised by all nations, was the first important step demanded.

These *Proceedings* were brought under the notice of His Excellency the Marquis of Lorne, then Governor-General of Canada. In the name of the Institute, they were submitted, in the form of a memorial, with the hope that His Excellency would see fit to lay them before the Imperial Government, that they would by these means obtain the attention of the several scientific bodies throughout Europe, and that some general systematic effort would be made in the right direction to secure the important objects sought to be attained.

Through the good offices of His Excellency, copies of the Canadian Institute *Proceedings* found their way to the British Admiralty, the Astronomer Royal, Greenwich, the Astronomer Royal for Scotland, Edinburgh, the Royal Society, the Royal Geographical Society, the Royal Astronomical Society, the Royal United Service Institute, and other societies of eminence and weight in the United Kingdom. Copies of the papers were likewise sent through the Imperial Government to the governments of the following countries, viz.:—

France,
Italy,
The United States,
Austria,
Brazil,
Japan,
Spain,
Switzerland,
Greece,
Germany,
Norway and Sweden,
Russia,
Belgium,
Denmark,
The Netherlands,
Portugal,
Turkey,
China.

In the year following, the American Metrological Society issued a Report of the Committee on Standard Time. The report bears the name of Mr. Cleveland Abbe, the Chairman of the Committee, and the date of May, 1879. It draws attention to many of the causes calling for the establishment of accurate time, and the attempts made since the establishment of the electro-magnetic telegraph to make the notation of time synchronous. While pointing out that this result had been obtained in Great Britain through the efforts of Prof. Airy, Mr. Cleveland Abbe gave a list of the various observatories on this continent which are in possession of the necessary apparatus and force proper to furnish astronomically accurate time by telegraph. Writing in February, 1880, while giving the resolution adopted by the society, recommending the adoption of accurate time by telegraph from an established astronomical observatory, Mr. Cleveland Abbe points out that the subject of accurate time has been taken up by the Horological Bureau of the Winchester Observatory of Yale College, and that the most perfect apparatus had been received for the purpose of distributing New York time with the highest degree of uniformity and accuracy.

Mr. Cleveland Abbe's own remarks on the subject are of high value. He forcibly points out the difficulties and inconveniences under which railway operations in America labour from the want of a proper system of time. To show this fact in greater force, he gives the 74 standards then followed. These several standards he proposed to set aside and replace by standards each differing one hour, or 15° of longitude.

While recommending this course, the report sets forth that the change could only be regarded as a step towards the absolute uniformity of all time-pieces, and the Society passed resolutions, that absolute uniformity of time is desirable; that the meridian six hours west of Greenwich should be adopted as the National Standard to be used in common on all railways and telegraphs, to be known as "Railroad and Telegraph Time;" that after July 4, 1880, such uniform Standard Time should be the legal standard for the whole country, and that the State and National Legislatures should be memorialised on the subject.

Mr. Cleveland Abbe in this report alluded to the previous *Proceedings* of the Canadian Institute.

The active sympathy of the Marquis of Lorne greatly aided the movement of Time-reform in its early stages. In 1879, in his official position as Governor-General, he had been the recipient of the papers published by the Canadian Institute, and had transmitted them to Great Britain, and through the Imperial Government to the several European centres. In 1880, it was learned that the Report to the American Metrological Society, above alluded to, would shortly be issued. Accordingly, advance copies were obtained from New York, and, together with additional papers issued by this Institute, they were transmitted by His Excellency to the following European Societies, and the special attention of their members was directed to the documents themselves:—

1.	The Institut de France	Paris.
2.	Société de Géographie	Paris.
3.	Société Belge de Géographie	Brussels.
4.	Königliche Preussische Akademie der Wissenschaften	Berlin.
5.	Gesellschaft für Erdkunde	Berlin.
6.	Kaiserliche Akademie der Wissenschaften	Vienna.
7.	K. K. Geographische Gesellschaft	Vienna.
8.	Nicolaievskaia Glavnaia Observatoria	Pultowa.
9.	Imper. Rousskae Geograficheskoe Obschestou	St. Petersburg.

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[1] This paper, giving the early history of a movement which is now attracting such general attention, we extract from a recently received volume of *Transactions* of the Canadian Institute.

10. Imper. Akademia Nauk . . . . . St. Petersburg.
11. Societé de Géographie . . . . . . Geneva.

By this means attention was obtained for the subject in Europe, and when I submit evidence of the fact, I think you will agree with me, that no little of the success which has attended the movement is owing to our late Governor-General. We must all acknowledge how much we are indebted to him for the great personal interest he has always shown on the subject. We are certainly warranted in forming the opinion, that the dissemination of these papers, under such distinguished auspices, awakened attention to the arguments they contain, and prepared the way for the subsequent action taken at the International Geographical Congress at Venice, at the Geodetic Congress at Rome, and more recently at the Conference at Washington.

Mr. Wilhelm Förster, director of the Berlin Observatory, enters into the subject at length in a paper "Zur Beurtheilung Einiger Zeitfragen, insbesondere gegen die Einführung einer deutschen Normalzeit." [A Review of some considerations on Time, especially against the introduction of German National Uniform Time.]

Mr. Förster proceeds to say: The British Government is now transmitting, through its representatives, although at the same time it declares itself neutral, a proposition which has been published by a society of scientific men in Canada, which aims at the establishment of a cosmopolitan normal datum (Prime Meridian) and of Universal Time, and also the establishment of 24 meridians of an hour apart, by which local time will be absorbed. The first proposal Mr. Förster describes as an important sign of the times and evidently favours it.

He strongly protests against the establishment of a National German Time; but for railway business, and for such matters of communication as require precision, also for the form of expression of all scientific relations to time, Mr. Förster points out that a Universal Time common to the whole world is to be recommended.

Dr. G. von Boguslavski, in the *Verhandlungen der Gesellschaft für Erdkunde* (*Transactions of the Geographical Society of Berlin*), commends the new scheme as it has been put forth in the Canadian Institute papers, and foretells that it will be a matter of fact in a short time.

Col. Aden, Director of the Military School, Belgium, has two papers in the *Bulletin de la Société Belge de Géographie*. He supports the proposal to establish Universal Time, and expresses the opinion that longitude throughout the world should have a common notation, dating from one universally adopted Prime Meridian.

Col. Wauverman, President of the Geographical Society of Antwerp, in the *Bulletin* of that society, 1882, advocates the change, and with ability meets the arguments raised against it, showing them to be groundless and arising from a want of thoroughly understanding the question.

In Spain, the proposals have met with full support. All the papers issued by the Canadian Institute have been translated and published in a paper of 80 pages by the Revista General de Marina. The translator, Don Juan Pastorin, an officer of the Spanish navy, is warm in his commendation of the scheme, and takes a wise and comprehensive view of the whole question. The Spanish Government secured the advantage of this gentleman's services as delegate to the Washington Conference.

M. Otto Struve, the well known Astronomer and Director of the Imperial Observatory, Pultowa, reports on the papers transmitted by Lord Lorne to the Imperial Academy of Science, St. Petersburg. He gives his adherence to the establishment of Universal Time, based, as suggested, on a Prime Meridian common to the whole globe, and strongly advocates counting the hours in one series up to 24.

In England, the Royal Society considered favourably both the establishment of a Universal Time and the determination of a common Prime Meridian. While the present Astronomer Royal, Mr. Christie, takes a favourable view of the question, his predecessor, Sir G. B. Airy, reported unfavourably. The report of the Astronomer Royal for Scotland, Prof. Piazzi-Smith, is decidedly adverse. These documents have been transmitted to the Institute.

In Italy, the Italian Geographical Society has given its countenance to a work by Mr. Fernando Bosari, who, in a pamphlet of 68 pages, reviews the whole question at length, and lays down three principles: 1. The determination of a Zero-meridian; 2. The establishment of Cosmopolitan Time based upon it; 3. The notation of the hours from 1 to 24 in a continuous series.

The question of Universal Time and the selection of a Prime Meridian is discussed with ability in a paper published by M. Thury, professor at the University of Geneva.

At the meeting of the Association for the Reform and Codification of the Laws of Nations at Cologne, Prussia, in 1881, the question of regulating time on the new system was considered and resolutions moved.

In the same year (1881), the subject occupied the attention of the International Geographical Congress at Venice, at which a delegate from the Canadian Institute attended. The general question was warmly discussed, and resolutions adopted. The appointment of an International Conference to meet at Washington, specially to consider the question, was then suggested by the Canadian delegate, and warmly supported by gentlemen representing the government and scientific societies of the United States. The President of the Congress communicated the resolutions to the Italian Government, and Prince Teano, on behalf of the Italian Government, undertook to conduct the official correspondence. Out of this appears to have sprung the important discussion at the meeting of the International Geodetic Association at Rome, in October, 1883, when the utility of Universal Time was recognised, and a special International Conference for the establishment of a zero-meridian for longitude and time recommended.

Returning to this side of the Atlantic, the question of regulating time for railway, telegraph, and civil purposes generally, was considered at the Convention of the American Society of Civil Engineers, held at Montreal, June 15, 1881, and a committee of men engaged in the management, and familiar with the economy of railways, appointed to examine the question. The committee has reported from time to time. They recognised that a proposition to reform the general time system of the country was a problem beset with difficulties, but it did not appear to them insolvable. It was felt, however, that the question affected so many interests that any change could only be effected by general concurrence.

To attain the end proposed by this society, the papers bearing on the question were printed, and a scheme modified on the *Proceedings* of the Canadian Institute was drawn up, under the title of "Cosmopolitan scheme for regulating time."

I may briefly recall the features of the scheme.

There should be one standard of absolute time, a Universal Day, based on the mean solar passage, at one particular meridian, the Prime or initial meridian for computing longitude. This Prime Meridian, together with the Universal Day, to be observed by all civilised nations.

There should be 24 secondary or hour-meridians established, 15 degrees of longitude apart, beginning with the Prime Meridian as zero.

To distinguish the Universal Day from local days, it should bear the title of "Cosmic Day." [1]

Cosmic Time is intended to be used to promote exactness in chronology, and to be employed in astronomy, navigation, meteorology and in synchronous observations throughout the world. To be employed in ocean telegraphy and generally in all operations non-local in character.

The several 24 meridians to be used as standards for local time around the globe. Applying the system to North America, the effect would be to reduce the standards to four or five, as suggested by the Metrological Society.

A circular, dated March 15, 1882, signed by Mr. John Bogart, the Secretary of the American Society of Civil Engineers, was forwarded to the leading men in railway direction, either as general managers, superintendents, or engineers, and to men of scientific attainments throughout the United States and Canada. The paper thus circulated contained 11 questions, and categorical replies were invited to them.

Replies were received and reported on at a Convention of the Society, held in Washington on May 15, 1882. The scheme submitted was generally and cordially approved.

An emphatic and unanimous opinion was expressed, that there should be established as early as possible a comprehensive system of Standard Time for North America.

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[1] [Note.—I may remark, that the designation "Cosmic" was first suggested, independently, by two Canadian gentlemen widely separated, by Mr. R. G. Haliburton, then in Algiers, and by Mr. Thomas Hector, of Ottawa. The etymology commends the use of the word. It has been accepted by a number of societies and by many individuals as appropriate and applicable.]

Of those who replied to the queries, 95 per cent. favoured the idea that there should be a common agreement between the standards of time in all countries. That while we must primarily look to our own convenience on this continent, it is proper to aim at eventually attaining general uniformity among all nations.

Seventy-six per cent. were in favour of reducing the standards in North America so that they would differ only by intervals of one hour, and 92 per cent. were in favour of a notation of the hours of the day by a single series from 1 to 24, instead of in two divisions, each of 12 hours.

The character of the replies received indicated that a remarkable unanimity of opinion prevailed in every section of the continent heard from. The Convention accordingly resolved that an attempt should be made to obtain European concurrence to the selection of a Prime Meridian on which a time-system could be definitely based. But, failing to obtain this recognition, the people of the Western Continent should determine a zero-meridian for their own use and guidance.

It was thereupon resolved to petition the Congress of the United States to take the matter into consideration. The American Metrological Society about the same time adopted a similar proceeding. The consequences were that a joint-resolution of the House of Representatives and the Senate was passed, authorising the President of the United States to call an International Conference to fix on and recommend for universal adoption a common Prime Meridian to be used in the reckoning of longitude and in the regulation of time throughout the world.

On the meeting of the American Association for the Advancement of Science in Montreal, in July, 1882, the subject was brought forward, and all the documents were submitted and discussed. It was agreed that the Association should co-operate with other bodies in furtherance of the movement.

On two occasions the Royal Society of Canada has had its attention directed to the matter, and this body has assisted in furthering the determination of the problem by its co-operation and by correspondence with the Government.

While some delay took place in summoning the International Conference by the President, in consequence of diplomatic correspondence on the subject, the question was ripening on both sides of the Atlantic for concerted action. Indeed, a decision with respect to the regulation of local time was anticipated by the railway authorities in North America, who adopted the system of hour-standards which had been prominently brought forward as described.

On November 18 of last year (1883) the new system of regulating railway time on this continent came into operation. There had been several preliminary meetings of railway managers; the last meeting was a Convention held in Chicago the previous October, and it was then determined immediately to carry out the change.

Mr. W. F. Allen, the secretary of this Convention, who also took a prominent part in effecting the adoption of the change, has given a history of the events leading to it. Upon this gentleman mainly fell the labour of arranging details, and he executed the difficult duties assigned to him with consummate ability. In the words of the historian, the transition from the old to the new system "was put into effect without any appreciable jar, and without a single accident occurring." According to this authority the first newspaper to advocate some change was the *Railroad Gazette* for April 2, 1870, and it is claimed that as early as 1869 Prof. Charles F. Dowd, Principal of Temple Grove Ladies' Seminary, Saratoga Springs, proposed a system of meridians based on the meridian of Washington at intervals of one hour, by which railways should be operated, and that an expression of his views was placed in the hands of the President of the New York and Canada Railroad. The proposition appears to have attracted attention in the *Travellers' Official Guide* of 1872. In 1873 it was brought before the Railway Association of America, not now in existence. A committee was appointed to examine into its merits; they failed to recognise its necessity, and recommended that the question of National Standard Time for use on Railways be deferred till it more clearly appeared that the public interest called for it.

Mr. Dowd's efforts to introduce a National Standard Time to meet the difficulties which were being developed were at the time imperfectly appreciated. He, however, has had the satisfaction of seeing a scheme unanimously accepted, and put in operation, which in essential features does not materially differ from that which he advocated; and he himself attended at the meeting of the American Metrological Society, and took part in the proceedings when the details of the new time arrangements were officially narrated.

Prominent among those who have earnestly laboured to advance the movement of time-reform is the distinguished President of Columbia College, New York. Dr. Barnard has from the first taken the deepest interest in the question, and few men have done so much to bring it to a practical issue. In the proceedings of the American Metrological Society for 1881 will be found a paper prepared by Dr. Barnard in 1872, and presented to an association which has since assumed an international character, and is known as the Association for the Reform and Codification of the Laws of Nations. In this paper Dr. Barnard recommends the selection of Greenwich as the Prime Meridian for the world, and he submits the views he held at that early date, which at this hour are of peculiar interest. He points out that "it is becoming a matter of greater importance every day that there should be established some universal rule for defining the calendar day for all the world."

I have alluded to the valuable report of Prof. Cleveland Abbe, of the United States Signal Service, to the Metrological Society, and I cannot deny myself the pleasure of acknowledging the services of the gentlemen with whom I have been associated on the special committee on Standard Time of the American Society of Civil Engineers, Mr. Charles Paine, of New York; Mr. Theodore N. Ely, of Altoona, Pennsylvania; Mr. J. M. Toucey, of the Hudson River Railway; Prof. Hilgard, Coast Survey, Washington; Prof. T. Egleston, of Columbia College: General T. G. Ellis, of Hartford, now unfortunately deceased, and Mr. John Bogart, Secretary of the Society.

The American Society of Civil Engineers, since meeting in Montreal, in 1881, has made persistent and continuous efforts in the common interest to advance the movement of time-reform, having greatly aided in bringing about the important change carried into effect a year ago. This Society is now directing attention to a reform of scarcely less importance, the notation of the hours of the day. At the Buffalo convention in June 1884, this particular question received prominent consideration in the address of the President, as well as in the report of the special committee. Since that date a correspondence has taken place between the Secretary and the railway managers in the United States and Canada. Already replies have been received from the representatives of some 60,000 miles of railway, 98 per cent. of whom have given expression to their sympathy with the movement, to abandon the old practice of halving the day, designating the two sets of 12 hours by the abbreviations A.M. and P.M., and are prepared to adopt a simple notation of 1 to 24 in a single series. The great telegraph interests of the country are likewise in full sympathy with it. The President of the Western Union Telegraph Company, Dr. Norwin Green, states that their telegraphic traffic is equal to the transmission of 44,000,000 messages a year, and the general adoption of the 24 o'clock system (as it has been designated), would be cordially welcomed by telegraphers. It would reduce materially the risk of errors, and to the company over which he presides, he says it would save the transmission by telegraph of at least 150,000,000 letters annually.

The branch literature bearing on the two questions of Universal Time and the establishment of a Prime Meridian, has been enriched by a series of papers which have appeared during the past year in the *International Standard*, a magazine published in Cleveland, Ohio. These papers are by the following gentlemen connected with the International Institute:—Rev. H. G. Wood, of Sharon, Pennsylvania; Prof. C. Piazzi-Smyth, Astronomer Royal for Scotland; Prof. John N. Stockwell, Astronomer, Cleveland; Mr. Jacob M. Clark, C.E., New York; Mr. William H. Searle, Pennsylvania; the late Abbé F. Moigno, Canon of St. Denis, Paris; Commodore Wm. B. Whiting, U. S. Navy; Mr. Charles Latimer, C.E., Cleveland; and others.

It will be seen from what I have submitted, that the proceedings have neither been few nor without success, and that since this Institute published the first issue of papers on Time and Time-reckoning, the subject has received much attention on both sides of the Atlantic. Societies with kindred pursuits, men of recognised merit in the scientific world, have turned to its examination and aided in its development. Some few men have acted in concert. The labours of others have been independent. Some of these names I have been able to record, but I fear that I neglect to include many of eminence because they are not known to me. It is this varied and widely diffused effort which has rendered possible the realisation of the practical results which I have the gratification to record, and all the members of this Society must equally join in the common satisfaction in the measure of success which has been achieved.

Six years back, when the subject was discussed in this hall, there were probably not a few who viewed the propositions then submitted as merely fanciful theories. Others, who did not refuse to recognise their bearing, entertained the feeling that many grave difficulties presented themselves to interfere with any successful attempt to reform or modify usages so ancient as the computation of time. But the Institute, as a body, was hopeful. The action taken by the Council to extend the field of discussion and awaken the attention of foreign communities, evinced confidence, and we may now ask, was this confidence justified? What are the facts to-day? Twelve months have passed since an important change in the notation of railway time was made with general approval throughout the length and breadth of North America; a revolution in the usages of 60,000,000 of people has been silently effected and with scarcely a trace that it has happened. That proceeding has been followed by events of equal importance. On October 1 last a body of accredited delegates from the different nations, on the invitation of the President of the United States, met in Conference to consider the problem first submitted to the world by this Institute. The delegates were the representatives of 25 civilised nations. The Conference continued during the whole month of October, and, as a body, they came to conclusions affecting all peoples living under our theories of civilisation.

It was early understood that a determination with respect to Universal Time was not possible without the general recognition of a Prime Meridian. Hence the importance attached to its choice, that it should be universally accepted.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—Abstract of a Paper on "Preliminary Results of a Comparison of Certain Simultaneous Fluctuations of the Declination at Kew and at Stonyhurst during 1883-84, as recorded by the Magnetographs." By the Rev. S. J. Perry, F.R.S., and Prof. B. Stewart, F.R.S.

The authors remark that such fluctuations almost always occur as couplets or groups of couplets; a couplet meaning first an ascent and then a descent, or the reverse. In their opinion this duality and the other facts of their paper can best be explained by supposing that a recorded magnetic fluctuation is the joint result of two causes: the one of these being a true magnetic change, and the other a secondary current caused by this change. The secondary current would probably appear as an earth-current. Its maximum strength would depend on the maximum rate of magnetic change, but as this last element is quite unknown, we may perhaps suppose that this maximum strength will be practically proportional to the mean rate of magnetic change.

On this supposition the authors suggest the following formula as capable of being used as a preliminary working hypothesis.

Let K denote the observed Kew change, and k the true magnetic change at Kew, also let t represent the duration; then $K = k\left(1 \mp \frac{\alpha}{t}\right)$ where α is a constant. Also if S represent the observed simultaneous Stonyhurst change, then $S = k\left(\beta \mp \frac{\gamma}{t}\right)$, the sign − being applicable to the first limb, and the sign + to the second limb of the couplet.

It follows from this that $\frac{S}{K} = \frac{\beta \mp \frac{\gamma}{t}}{1 \mp \frac{\alpha}{t}}$, or, in other words, that the ratio between the Kew and Stonyhurst observed disturbances will be a function of the duration, quite apart from all theoretical considerations, which can only in the meantime be regarded as pointing out a method of treatment. The authors then practically discuss their results, and have obtained the following preliminary conclusions:—

(1) S is always greater than K, or the ratio $\frac{S}{K}$ is always greater than unity.

(2) This ratio appears to depend in some way on the duration of the disturbance;

(3) But not, as far as can be seen at present, upon its magnitude.

Finally, they hope to make a more extended investigation of the subject, going over a greater number of years, and perhaps adding to their methods of treatment.

"On the Limited Hydration of Ammonium Carbamate." By H. J. H. Fenton.

The hydration of ammonium carbamate affords an example of a chemical action of the simplest type, namely, the direct union of two simpler molecules to form one more complex—

$$\mathrm{CO(NH_2)(ONH_4) + OH_2 = CO(ONH_4)_2}.$$

There are but few actions of this type which can be investigated when all the substances concerned are in the liquid state, and all extraneous matter absent.

In a former paper it was shown that ammonium carbamate, when acted upon by sodium *hypochlorite* in presence of sodium hydroxide, yields one half of its nitrogen in the free state, the other half remaining in the form of sodium carbamate—

$$\mathrm{2CO(NH_2)(ONH_4) + 3NaClO + 2NaOH = 2CO(NH_2)(ONa) + 3NaCl + 5OH_2 + N_2}.$$

Sodium *hypobromite* at once decomposes sodium carbamate, yielding the nitrogen in the free state. This, in fact, is claimed as a specific reaction for carbamates, since no other substance yet investigated will yield free nitrogen by action of a hypobromite *after* the completed action of a hypochlorite.

Based upon this reaction, then, we have a direct and simple method of determining the amount of carbamate existing in a solution at any given time.

Experiments were conducted with a view of examining the influences of time, mass, and temperature upon the hydration of ammonium carbamate, and also the reverse action, namely, the dehydration of normal ammonium carbonate into ammonium carbamate. The hydration is expressed by the ratio—

$$\frac{\text{molecules of water assimilated}}{\text{molecules of carbamate taken}}.$$

(1) *Influence of Time.*—Solutions of ammonium carbamate of different strengths were examined at stated intervals. In all cases the action proceeds rapidly at first, becomes progressively slower, and finally reaches a limit short of complete hydration.

The time required to reach a determinate state of hydration is less as the relative number of water-molecules is greater.

(2) *Influence of Mass.*—The hydration is shown to be a function of the number of water-molecules present. As far as the action could be legitimately studied, the minimum hydration corresponded to the case in which the substances are present in equal molecular proportions.

(3) *Influence of Temperature.*—The hydration is in all cases less, as the temperature is lower. Probably at a sufficiently low temperature the hydration would be practically *nil* when the substances are present in equal molecular proportions—*i.e.* ammonium carbamate and water would practically not combine at all.

(4) *Dehydration of Normal Ammonium Carbonate.*—It was shown that this salt undergoes dehydration in solution, becoming in part converted into carbamate. The dehydration is greater, as the relative number of water-molecules is less. It seems not unlikely that if the same relative number of molecules could be started with, the same equilibrium state between carbamate, carbonate, and water, would be arrived at for the same temperature, whether ammonium carbamate or normal ammonium carbonate were initially taken.

Since there is a tendency for normal ammonium carbonate to become in part dehydrated in aqueous solution, and for the system to come to a state of equilibrium where the carbamate and carbonate co-exist, it seems probable that the hydrolysis of urea under the action of ferments may be less simple than is usually represented. The author proposes to attack the problem by a method based on the actions of sodium hypochlorite and hypobromite, by means of which it is possible to detect, and quantitatively estimate, urea, carbamic acid, and ammonia, when all present in the same solution. A preliminary trial of the method gave satisfactory results.

Geological Society, December 16, 1885.—W. Carruthers, Vice-President, in the chair.—Charles John Alford, Samuel Blows, James Warne Chenhall, William Farnworth, Paget